

10-25-00

A

UTILITY PATENT APPLICATION TRANSMITTAL
(Large Entity)*(Only for new nonprovisional applications under 37 CFR 1.53(b))*Docket No.
BUR9-2000-0047-US1Total Pages in this Submission
4**TO THE ASSISTANT COMMISSIONER FOR PATENTS**Box Patent Application
Washington, D.C. 20231

Transmitted herewith for filing under 35 U.S.C. 111(a) and 37 C.F.R. 1.53(b) is a new utility patent application for an invention entitled:

METHOD FOR THIN FILM LASER REFLECTANCE CORRELATION FOR SUBSTRATE ETCH ENDPOINT**24241**

and invented by:

Jason Michael Benz

PATENT TRADEMARK OFFICE

If a **CONTINUATION APPLICATION**, check appropriate box and supply the requisite information:☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____

Which is a:

☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____

Which is a:

☒ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.: _____

Enclosed are:

Application Elements

1. ☒ Filing fee as calculated and transmitted as described below
2. ☒ Specification having 17 pages and including the following:
 - a. ☒ Descriptive Title of the Invention
 - b. ☐ Cross References to Related Applications *(if applicable)*
 - c. ☐ Statement Regarding Federally-sponsored Research/Development *(if applicable)*
 - d. ☐ Reference to Microfiche Appendix *(if applicable)*
 - e. ☒ Background of the Invention
 - f. ☒ Brief Summary of the Invention
 - g. ☒ Brief Description of the Drawings *(if drawings filed)*
 - h. ☒ Detailed Description
 - i. ☒ Claim(s) as Classified Below
 - j. ☒ Abstract of the Disclosure

UTILITY PATENT APPLICATION TRANSMITTAL
(Large Entity)

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Docket No.
BUR9-2000-0047-US1

Total Pages in this Submission
4

Application Elements (Continued)

3. ☒ Drawing(s) *(when necessary as prescribed by 35 USC 113)*
- a. ☒ Formal Number of Sheets 3 (Figs. 1A-8)
- b. ☐ Informal Number of Sheets _____
4. ☒ Oath or Declaration
- a. ☒ Newly executed *(original or copy)* ☐ Unexecuted
- b. ☐ Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional application only)*
- c. ☒ With Power of Attorney ☐ Without Power of Attorney
- d. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application,
see 37 C.F.R. 1.63(d)(2) and 1.33(b).
5. ☐ Incorporation By Reference *(usable if Box 4b is checked)*
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under
Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby
incorporated by reference therein.
6. ☐ Computer Program in Microfiche *(Appendix)*
7. ☐ Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all must be included)*
- a. ☐ Paper Copy
- b. ☐ Computer Readable Copy *(identical to computer copy)*
- c. ☐ Statement Verifying Identical Paper and Computer Readable Copy

Accompanying Application Parts

8. ☒ Assignment Papers *(cover sheet & document(s))*
9. ☐ 37 CFR 3.73(B) Statement *(when there is an assignee)*
10. ☐ English Translation Document *(if applicable)*
11. ☒ Information Disclosure Statement/PTO-1449 ☒ Copies of IDS Citations
12. ☐ Preliminary Amendment
13. ☒ Acknowledgment postcard
14. ☒ Certificate of Mailing
- ☐ First Class ☒ Express Mail *(Specify Label No.):* EL046033067US

UTILITY PATENT APPLICATION TRANSMITTAL
(Large Entity)

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Docket No.
BUR9-2000-0047-US1

Total Pages in this Submission
4

Accompanying Application Parts (Continued)

15. ☐ Certified Copy of Priority Document(s) *(if foreign priority is claimed)*

16. ☐ Additional Enclosures *(please identify below):*

Request That Application Not Be Published Pursuant To 35 U.S.C. 122(b)(2)

17. ☐ Pursuant to 35 U.S.C. 122(b)(2), Applicant hereby requests that this patent application not be published pursuant to 35 U.S.C. 122(b)(1). Applicant hereby certifies that the invention disclosed in this application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication of applications 18 months after filing of the application.

Warning

An applicant who makes a request not to publish, but who subsequently files in a foreign country or under a multilateral international agreement specified in 35 U.S.C. 122(b)(2)(B)(i), must notify the Director of such filing not later than 45 days after the date of the filing of such foreign or international application. A failure of the applicant to provide such notice within the prescribed period shall result in the application being regarded as abandoned, unless it is shown to the satisfaction of the Director that the delay in submitting the notice was unintentional.

UTILITY PATENT APPLICATION TRANSMITTAL
(Large Entity)

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Docket No.
BUR9-2000-0047-US1

Total Pages in this Submission
4

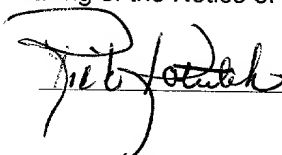
JC841 U.S. PRO
09/695028
10/24/00

Fee Calculation and Transmittal

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	30	- 20 =	10	x \$18.00	\$180.00
Indep. Claims	3	- 3 =	0	x \$80.00	\$0.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
BASIC FEE					\$710.00
OTHER FEE (specify purpose)					\$0.00
TOTAL FILING FEE					\$890.00

- ☐ A check in the amount of _____ to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. **09-0456** as described below. A duplicate copy of this sheet is enclosed.
- ☒ Charge the amount of **\$890.00** as filing fee.
 - ☒ Credit any overpayment.
 - ☒ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
 - ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).



Signature

Dated: **10/24/00**

Richard M. Kotulak, Esq. (Reg. No. 27,712)
International Business Machines Corporation
Intellectual Property Law - Zip 972E
1000 River Street
Essex Junction, VT 05452
(802)769-4457

CC:

APPLICATION
FOR
UNITED STATES LETTERS PATENT

APPLICANT NAME: Jason Michael Benz

TITLE: METHOD FOR THIN FILM LASER
REFLECTANCE CORRELATION FOR
SUBSTRATE ETCH ENDPOINT

DOCKET NO.: BUR9-2000-0047-US1

INTERNATIONAL BUSINESS MACHINES CORPORATION

Express Mail Label EL046033067US

METHOD FOR THIN FILM LASER REFLECTANCE CORRELATION FOR SUBSTRATE ETCH ENDPOINT

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention generally relates to endpoint detection, and more particularly to
thin film laser reflectance correlation for quartz etch endpoint.

Description of the Related Art

10 Several conventional endpoint detection techniques exist in the industry for detecting the
endpoint of substrates/materials such as quartz, etc. Examples include laser reflectance, optical
emission spectroscopy, and mass spectroscopy. These techniques have been proven to work
quite well for several plasma applications, etc. In each case, a change in either the film or the
plasma, signals the endpoint of the film being etched.

15 However, these methods prove to be useless in the fabrication of alternating phase-shift
masks because this particular process requires that portions of the photomask substrate (e.g.,
quartz) be etched to a specific depth. Since this involves etching into a bulk quartz substrate,
where there is no etch stop, no change in either the film or plasma characteristics can be
observed. This is a problem.

Previously, etching to the correct depth in quartz substrate was almost an art form, which also required some luck. The process, referred to as an “iterative etch process”, would be typically performed as follows.

First, the operator assumes a quartz etch rate (e.g., based on the last run completed) and determines the time needed to etch about 80% of the desired depth. Next, the part is etched. Then, the part is unloaded and taken to a profilometer, where the approximate etch depth is measured. Etch rate is then re-calculated and then the part is loaded back into the etch tool to complete the remaining etch.

However, not only does this procedure require a lot of work, it also requires an extremely stable process.

Moreover, if the process etch rate fluctuates, the chances of “hitting” the correct depth drops dramatically. The procedure also demands a skilled operator, and several tool transfers, both of which are costly and not manufacturing-friendly.

Thus, these methods are very inaccurate and result in tedious, time-consuming operations requiring highly-skill, highly-trained operators. Otherwise, yield is low and waste of materials is high.

Figures 1A-3B illustrate the conventional etching process and the laser reflectance signal for the conventional dry etching of a chrome on glass etch.

In Figure 1A, a substrate 1 (e.g., quartz) is shown having a chrome material 2 deposited thereon and a chromium oxide 3 is formed over the chrome 2. A laser 4 is shown for etching through the chromium oxide 3 (CrOx) to remove the chrome 2 on the substrate. A resist is

shown for use as a patterning mask. Figure 1B shows the voltage signal as a function of time at the start of etching to represent the reflectance of the laser.

Figures 2A and 2B respectively illustrate the etching of the CrOx and the associated waveform of the reflectance signal.

Figures 3A and 3B respectively illustrate the etching and removal of the Cr from the quartz substrate and the associated waveform of the reflectance signal until the endpoint is detected. As is evident, the reflectance signal changes as the etching continues.

Thus, Figures 1A-3B illustrate a typical laser reflectance trace used to etch chrome on the quartz substrate. This also represents typical methods used for endpointing on several types of dry etching processes, by simply changing the films involved, or the curve. The voltage signal could also be a wavelength signal emitted from the plasma (used in optical emission spectroscopy). In this particular case, in the conventional method, the laser is focused on the primary film (chrome). Since the chrome is reflective, and the substrate (quartz) below it is not reflective, by observing the laser reflectance voltage signal, which represents the amount of reflectivity, it is easy to judge when the chrome film has been completely etched. As the chrome oxide (CrOx), or anti-reflective layer, is quickly etched away the signal rises. At the peak of the signal, the chrome is exposed and begins to be etched away. When the chrome becomes thin, some of the signal is lost to transmission. Finally, when no chrome is remaining the signal flattens out due to the presence of the secondary film, quartz, which is transmissive.

Typical endpoint methods use software algorithms to detect a change in the output curve to trigger endpoint, as was done in the above example. However, as described above, the

problem with etching quartz lies in the fact that there will be no change in the quartz film, or plasma to trigger an endpoint.

Typically, in alternating photomask production, a standard binary mask is used (e.g., chrome on a quartz substrate). As mentioned above, to etch the quartz substrate to a desired target depth, the iterative etch process is used. The idea behind this process is to etch to a pre-selected time. The etch depth is then measured to determine the etch rate. That calculated etch rate is then used to determine the etch time for the second etch pass. As mentioned above, this process has several problems including several tool in/out (tool transfers leading to additional defects such as reduced yield), potential for operator error, increased defects, and it would be very susceptible to process variations. The use of an endpoint method would show tremendous benefits.

SUMMARY OF THE INVENTION

In view of the foregoing and other problems, drawbacks, and disadvantages of the conventional methods, an object of the present invention is to provide a method for thin film laser reflectance correlation.

In a first aspect, a method of etching a substrate according to the present invention includes measuring a reflectance signal from a reflective material deposited on the substrate as the substrate is being etched, correlating the substrate etch rate to the reflectance signal from the

reflective material, and using the etch relation between the substrate and the reflective material to determine the etch target.

In a second aspect, a method of etching a material includes measuring a reflectance signal from a correlation material that is removed from the path of a second material that is to be etched as the second material is etched, correlating the second material etch rate to the reflectance signal from the correlation material, and using the etch ratio between the correlation material and the second material to determine the etch target.

In a third aspect, a method of etching a semiconductor substrate includes measuring a reflectance signal from an opaque material deposited on the semiconductor substrate as the semiconductor substrate is being etched, correlating the semiconductor substrate etch rate to the reflectance signal from the opaque material, and using the etch relation between the semiconductor substrate and the opaque material to determine the etch target.

Generally, the invention take advantages of a metal film (e.g., a chrome film) which is already on a photomask used with the etching process. For purposes hereinbelow, chrome will be assumed to be the metal film, but of course as would be known by one originally skilled in the art after taking the present specification any metal (or other opaque material) providing a predetermined reflectance signal could be used. The surface of the chrome film contains an anti-reflective chrome oxide. This film is etched during the quartz etch process. By correlating the quartz etch to the rate of the chrome oxide etch, the reflectance signal from the chrome can be used to determine an endpoint for the quartz etch process.

With the unique and unobvious features of the invention, even if the process etch rate fluctuates, the correct depth will still be etched. Further, a skilled operator is not required nor are

the several tool transfers which are required by the conventional methods. Thus, a low-cost, efficient method is provided, thereby resulting in greater yield and less waste of materials.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of a preferred embodiment of the invention with reference to the drawings, in which:

 Figures 1A-3B illustrate a conventional etching process and the laser reflectance signal for the conventional etching for chrome on glass dry etch;

10 Figures 4A-6D illustrates the inventive etching process and the laser reflectance signal for quartz dry etching (using CrOx as an exemplary material);

 Figure 7 is a flowchart of the inventive method 700 of etching a substrate and using laser reflectance correlation for etching endpoint detection; and

15 Figure 8 illustrates a relationship of laser reflectance as a function of time for quartz endpoint.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Referring now to Figures 4A-8, the method of the present invention will be described hereinbelow.

Generally, the present invention takes advantage of the metal (e.g., chrome) film which is already on a photomask to be used with the present invention.

5 That is, the surface of the chrome film contains an anti-reflective chrome oxide. This film is attacked during the quartz etch. By correlating the quartz etch to the rate of the chrome oxide etch, the reflectance signal from the chrome can be used to determine an endpoint for the quartz. It is noted that, as mentioned above, other materials could be used for correlating their etch rate with the etching of the underlying substrate. Similarly, the substrate is not limited to quartz, but could be other materials such as silicon, Gallium Arsenide, or any deep trench etching application material.

10 Thus, knowing that the quartz etch process etches the chrome oxide as well, and knowing the behavior of the laser reflectance signal of the chrome oxide, as shown above, a potential endpoint method for etching quartz has emerged. The idea behind thin film laser reflectance correlation is to use a secondary film only to correlate, and trigger an endpoint on the primary film being etched.

15 In this particular case, the chrome film acts as the secondary film and the quartz substrate is of course the primary film, or the film being etched. Unlike other endpoint methods, the output being monitored for the endpoint detection is not physically representing the film being etched.

20 Referring now to the drawings, and more particularly to Figure 4A, a structure 40 is shown for being etched. That is, structure 40 includes a substrate 41, a metal 42 (e.g., chrome)

formed on the substrate 41, an oxide 43 (e.g., chrome oxide) formed on the metal 42, and a resist 44 for patterning the structure of interest. A laser 45 is shown for emitting a signal to the oxide 43 such that its reflectance can be measured. Figure 4B illustrates the voltage signal as a function of time.

5 Figures 5A and 5B respectively illustrate the etching of the CrOx 43 and the associated waveform of the reflectance signal.

Figures 6A and 6B respectively illustrate the further etching and further removal of the metal (chrome) oxide from the substrate and the associated waveform of the reflectance signal as a function of voltage over time and the targeted voltage difference.

10 For further ease of understanding, a flowchart of the inventive method 700 of etching a substrate, is shown in Figure 7.

That is, in step 701, a reflectance signal is measured from an opaque material (e.g., such as metal or metal oxide, etc.) deposited on a substrate (e.g., quartz, silicon, etc.) as the substrate is being etched.

15 In step 702, the substrate etch rate is correlated to the reflectance signal from the opaque material.

Finally, in step 703, by using the etch relation between the substrate and the opaque material, the etch target can be determined. In the exemplary application, a depth of the etch or some other characteristic of the etch target can be determined.

20 Thus, as evident from the above, a key difference between the invention and the conventional endpoint detection methods is that the output being monitored for endpoint detection is not physically representing the film being etched.

That is, by calculating the selectivity of the quartz substrate to the chrome oxide, the desired quartz etch depth can be translated into a chrome, or chrome oxide etch depth. Since the chrome oxide is not completely removed, the laser reflectance voltage climbs at a much slower, and linear pace. The laser reflectance voltage signal can then be targeted to specified chrome oxide depth. When a certain voltage delta has been observed, the etch process is discontinued. Assuming selectivity has remained constant, if the correct chrome oxide depth has been obtained then the quartz substrate should also be etched to the desired target.

The benefits of using this method include all the benefits of other endpoint methods used throughout the industry. The process is now less susceptible to process variations, operator error, and defects. Less tool in/outs saves on process time, as well as defects. This method also does not require any additional process steps, or equipment, and furthermore it takes advantage of the metal (chrome) film which is already in the process.

Two test plates were performed to determine the target signal to stop etching. Data from these plates is shown in Figure 8.

As shown, the data suggests that the method works with reasonable repeatability, and within specifications. Each plate was etched with different processes. This shows that the method is effective across different process windows. The first plate shows a small endpoint site, whereas test plate 2 shows a larger endpoint site over chrome. Thus, a different test plate was used which effected the loading (etch rate). The plate was etched reasonably close to the targeted depth.

Hence, using the chrome for an endpoint signal solves many of the problems of the conventional methods. Use of an endpoint trace allows for better manufacturability. The skill of

the operator is not as critical, and it allows for some process variations. Also, only one tool transfer (as opposed to three transfers as described above) is necessary.

A major advantage of this endpoint solution is that it requires no additional, or special processing. The inventive endpoint procedure can be inserted easily into the process flow, and makes the etch process more manufacturable than it is now. Further, the inventive method has improved turn-around-time, low cost, improved efficiency, and improved manufacturability.

While the invention has been described in terms of a preferred embodiment, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the appended claims.

CLAIMS

What is claimed is:

1. A method of etching a substrate, comprising:
measuring a reflectance signal from a reflective material deposited on said substrate as
5 the substrate is being etched;
correlating the substrate etch rate to the reflectance signal from the reflective material;
and
using the etch relation between the substrate and the reflective material to determine the
etch target.
10
2. The method of claim 1, wherein said substrate comprises quartz.
3. The method of claim 1, wherein said reflective material comprises metal.
4. The method of claim 3, wherein said metal comprises chrome.
- 15 5. The method of claim 3, wherein said metal is formed on a photomask formed for patterning
said substrate.

6. The method of claim 3, wherein said metal has a metal oxide thereon, and wherein by correlating the substrate etch to the rate of the metal oxide etch, the reflectance signal from the metal is usable in determining an endpoint for the substrate etch.

7. The method of claim 1, wherein said reflective material comprises metal having a metal oxide thereon, and said substrate etch also etches said metal oxide on said metal, and wherein the reflectance correlation uses said metal as a secondary film only to correlate, and trigger an endpoint on the substrate as a primary film being etched,

wherein an output being monitored for endpoint detection is not physically representing a film being etched.

8. The method of claim 3, wherein a surface of said metal contains an anti-reflective metal oxide, which is attacked during the substrate etch.

9. The method of claim 1, wherein said reflective material includes a metal having metal oxide formed thereon, and wherein an output being monitored for endpoint detection does not physically represent the film being etched, such that by calculating a selectivity of the substrate to the metal, a desired substrate etch depth is translatable into one of a metal etch and a metal oxide etch depth.

10. The method of claim 9, wherein the metal oxide is not completely removed, such that a waveform of the reflectance voltage climbs linearly and such that the reflectance voltage signal is targetable to a specified metal oxide depth.

11. The method of claim 9, wherein when a certain voltage difference is observed, the etch process is discontinued.

12. A method of etching a material, comprising:

measuring a reflectance signal from a correlation material that is removed from the path of a second material that is to be etched as the second material is etched;

correlating the second material etch rate to the reflectance signal from the correlation material; and

using the etch ratio between the correlation material and the second material to determine the etch target.

13. The method of claim 12, wherein said second material comprises quartz.

14. The method of claim 12, wherein said correlation material comprises metal.

15. The method of claim 14, wherein said metal comprises chrome.

16. The method of claim 14, wherein said metal is formed on a photomask formed for patterning said second material.

17. The method of claim 12, wherein the correlation material includes a metal oxide thereon, and wherein by correlating the second material etch to the rate of the metal oxide etch, the reflectance signal from the metal is usable in determining an endpoint for the substrate etch.

18. The method of claim 12, wherein said second material etch also etches a metal oxide on said metal, and wherein a thin film reflectance correlation uses said metal as a secondary film only to correlate, and trigger an endpoint on the second material as a primary film being etched,

wherein an output being monitored for endpoint detection is not physically representing a film being etched.

19. The method of claim 14, wherein a surface of said metal contains an anti-reflective metal oxide, which is attacked during the second material etch.

20. The method of claim 12, wherein said correlation material includes a metal oxide formed thereon, and wherein an output being monitored for endpoint detection does not physically represent the film being etched, such that by calculating a selectivity of the second material to the metal, a desired second material etch depth is translatable into one of a metal etch and a metal oxide etch depth.

21. The method of claim 20, wherein the metal oxide is not completely removed, such that a waveform of the reflectance voltage climbs linearly and such that the reflectance voltage signal is targetable to a specified metal oxide depth.

22. The method of claim 12, wherein when a certain voltage difference is observed, the etch process is discontinued.

23. A method of etching a semiconductor substrate, comprising:

measuring a reflectance signal from an opaque material deposited on said semiconductor substrate as the semiconductor substrate is being etched;

correlating the semiconductor substrate etch rate to the reflectance signal from the opaque material; and

using the etch relation between the semiconductor substrate and the opaque material to determine the etch target.

24. The method of claim 23, wherein said semiconductor substrate comprises quartz.

25. The method of claim 23, wherein said opaque material comprises metal.

26. The method of claim 25, wherein said metal comprises chrome.

27. The method of claim 25, wherein said metal is formed on a photomask formed for patterning said substrate.

28. The method of claim 25, wherein said metal has a metal oxide thereon, and wherein by correlating the substrate etch to the rate of the metal oxide etch, the reflectance signal from the metal is usable in determining an endpoint for the substrate etch.

29. The method of claim 23, wherein said opaque material comprises metal having a metal oxide thereon, and said substrate etch also etches said metal oxide on said metal, and wherein the reflectance correlation uses said metal as a secondary film only to correlate, and trigger an endpoint on the substrate as a primary film being etched,

wherein an output being monitored for endpoint detection is not physically representing a film being etched.

30. The method of claim 25, wherein a surface of said metal contains an anti-reflective metal oxide, which is attacked during the substrate etch.

METHOD FOR THIN FILM LASER REFLECTANCE CORRELATION FOR SUBSTRATE ETCH ENDPOINT

ABSTRACT

5 A method of etching a substrate, includes measuring a reflectance signal from a
reflective material deposited on the substrate as the substrate is being etched, correlating the
substrate etch rate to the reflectance signal from the reflective material, and using the etch
relation between the substrate and the reflective material to determine the etch target.

10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995

Fig. 1A

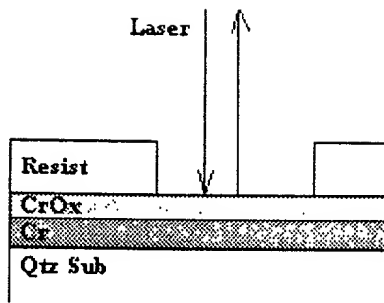


Fig. 2A

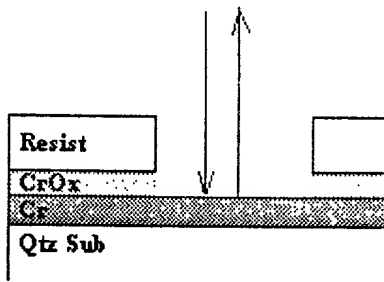


Fig. 3A

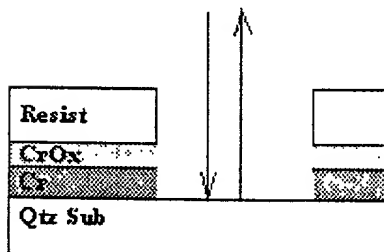


Fig. 1B

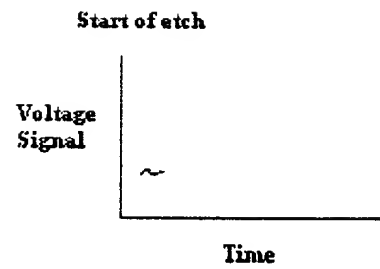


Fig. 2B

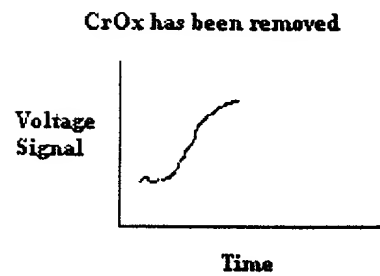
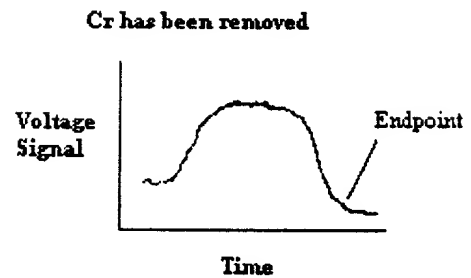


Fig. 3B



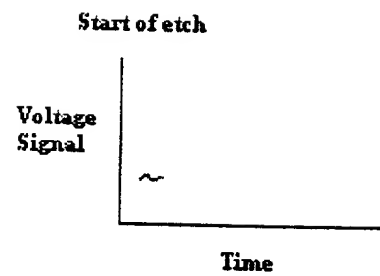
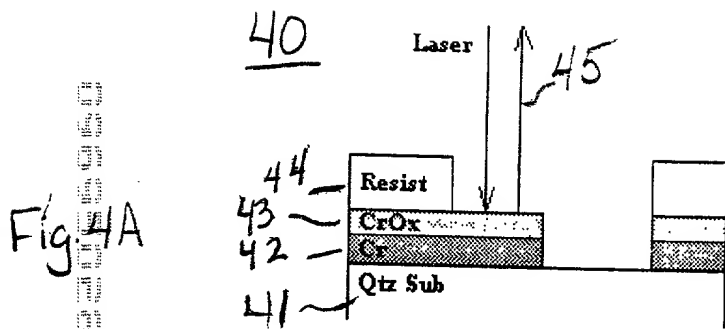


Fig. 4B

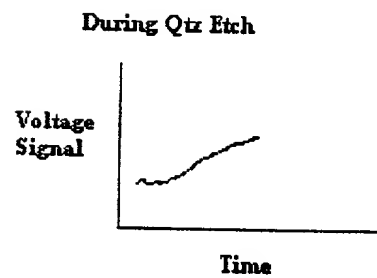
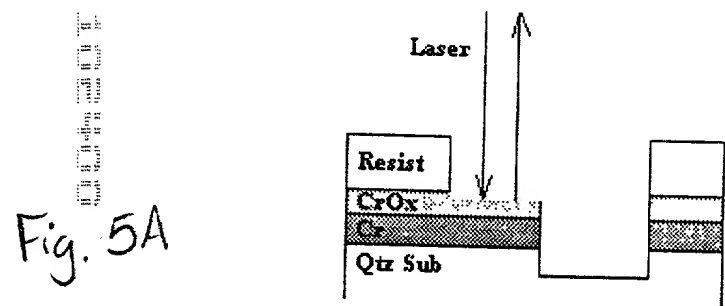


Fig. 5B

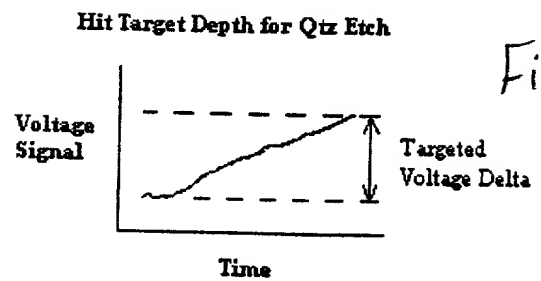
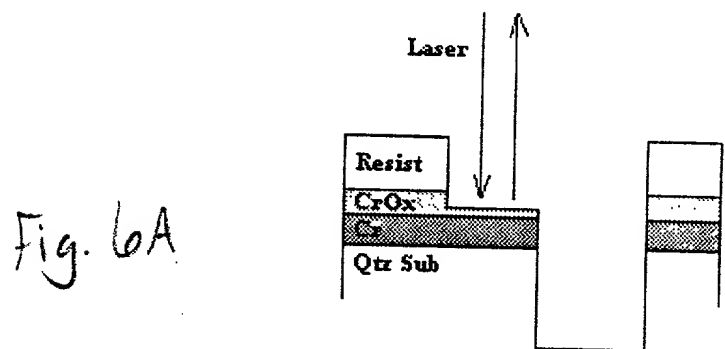


Fig. 6B

Fig. 7

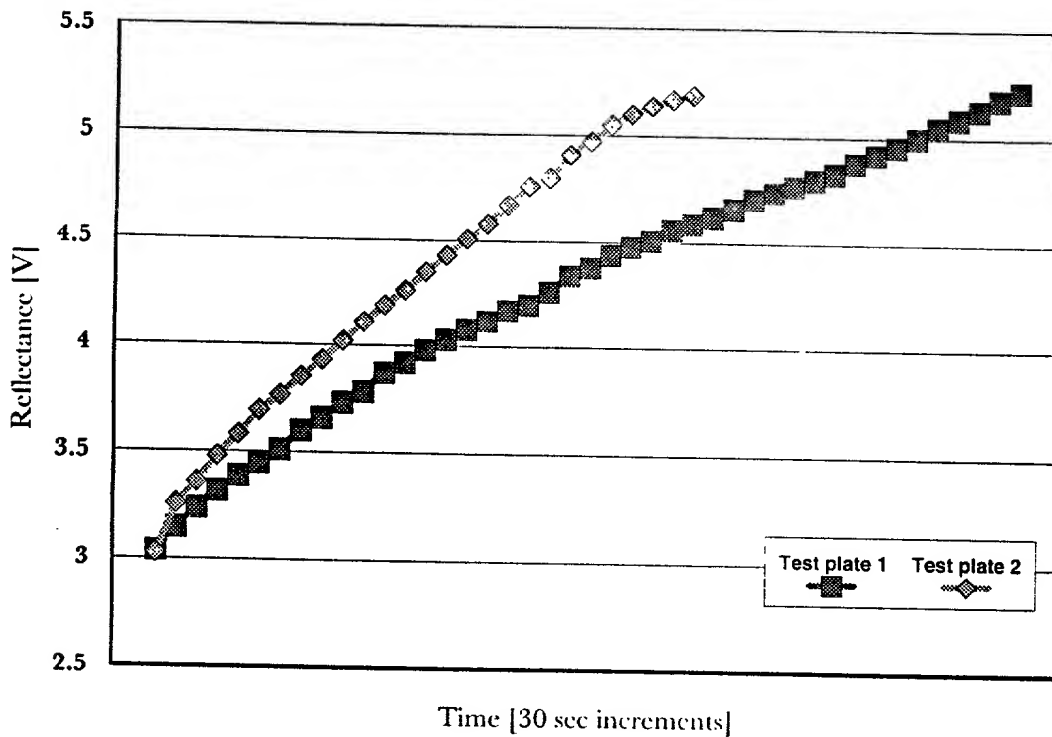
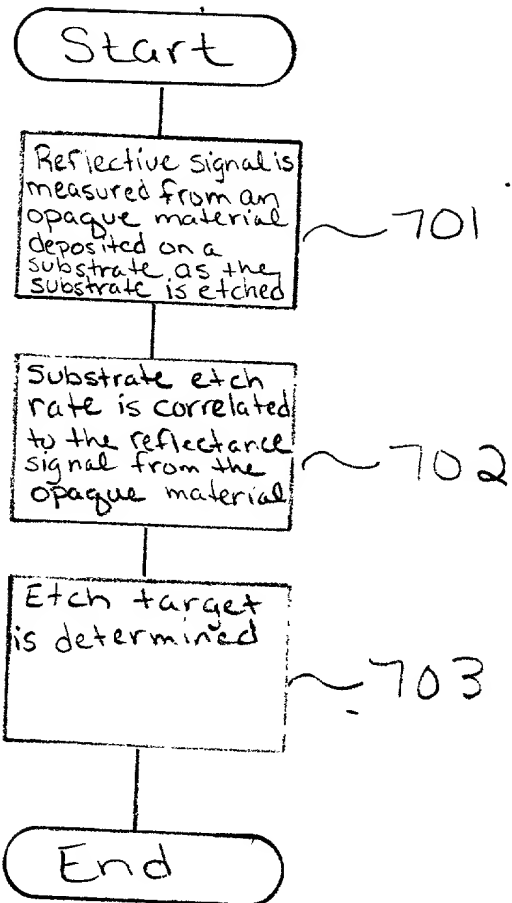
700

Fig. 8

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: METHOD FOR THIN FILM LASER REFLECTANCE CORRELATION FOR SUBSTRATE ETCH ENDPOINT

the specification of which:
(check one)

☒ is attached hereto.

☐ was filed on _____, as Application Serial No. _____ and was amended on _____.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s):

Number	Country	Day/Month/Year	Priority Claimed
--------	---------	----------------	------------------

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S. Applications:

Serial No.	Filing Date	Status
------------	-------------	--------

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

As a named inventor, I hereby appoint the following attorneys and/or agents to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Mark F. Chadurjian (Reg. No. 30,739), Richard A. Henkler (Reg. No. 39,220), Richard M. Kotulak (Reg. No. 27,712), James M. Leas (Reg. No. 34,372), William D. Sabo (Reg. No. 27,465), Eugene I. Shkurko (Reg. No. 36,678), Robert A. Walsh (Reg. No. 26,516), Howard J. Walter, Jr. (Reg. No. 24,832), Christopher A. Hughes (Reg. No. 26,914), Edward A. Pennington (Reg. No. 32,588), John E. Hoel (Reg. No. 26,279), Joseph C. Redmond, Jr., (Reg. No. 18,753), Sean M. McGinn, (Reg. No. 34,386), and Frederick W. Gibb, III, (Reg. No. 37,629).

Send all correspondence to: **Sean M. McGinn, McGinn & Gibb, P.C., 1701 Clarendon Boulevard, Suite 100, Arlington, Virginia 22209.**
Customer No. 21254

Telephone calls should be directed to Sean M. McGinn, McGinn & Gibb, P.C. at (703) 294-6699.

(1) Inventor: Jason Michael Benz

Signature: _____

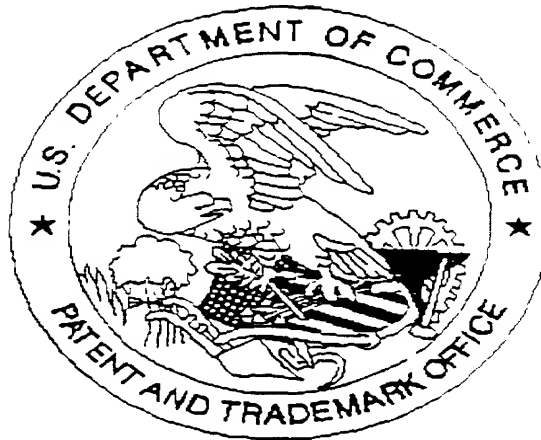
Date: _____

Residence: 12 Lyon Lane, Essex Junction, VT 05452

Citizenship: United States of America

Post Office Address: Same as Residence

United States Patent & Trademark Office
Office of Initial Patent Examination -- Scanning Division



Application deficiencies were found during scanning:

☐ Page(s) _____ of _____ were not present:
for scanning. (Document title)

☐ Page(s) _____ of _____ were not present:
for scanning. (Document title)

No certificate of express mail.

☐ Scanned copy is best available.
